The new instability plays a very important role in the mixing enhancement. The new instability mechanism not only enhances Kelvin-Helmholtz vortices, but also streamwise vortices, e.g. corner vortices, while Wygnanski discloses only Kelvin-Helmholtz vortices.

Since Wygnanski is based on Kelvin-Helmholtz instability mechanism, the mixing enhancement (the spreading rate of the mixing layer is used as criterion for mixing) is usually two times of the unforced one. The mixing region has a shape of a wedge as shown in Wygnanski's Fig. 2, 3, 4 and 5. This is related to the saturation phenomenon, i.e. when forcing amplitude is sufficient high, the increase of forcing amplitude will have no influence for mixing enhancement. Thus, the high amplitude is not necessary. Therefore Wygnanski requires very small total energy.

However, the claimed invention has no such saturation limitation due to the streamwise vortices and therefore can result in a much more dramatic mixing, and the spreading angle can even be 180°, the limitation of the possible maximum enhancement (see also the example of figure 2 of the new invention). The shape of mixing region is not necessarily wedge-shaped due to the dramatic mixing.

As Wygnanski does not teach corner vortices, both the start of the mixing region and the oscillation-inducing element could in many cases in practice be used in axisymmetric, i.e. annular or taurus shape. In such cases, there are no corners, and therefore no corresponding streamwise vortices. Thus the mixing enhancement is limited.

For the claimed invention the splitter plates are designed to produce more corners and thus the corner vortices and to enhance their development downstream of the trailing edge. For instance, this can be realized in a confined configuration combining the splitter plate and the side wall.

Furthermore, the excitation frequency used in the invention of Wygnanski depends on flow convection velocity. The claimed invention, however, depends on some narrow forcing frequency, which does not depend on the flow convection velocity. Moreover since the corner vortices play an important role in the mixing enhancement of the claimed invention

and their originals are independent of the velocity values of the two streams, the two streams can have the same velocity (if it is necessary) for the mixing enhancement. In this case the Karman vortex street results from the inherent instability mechanism. In Wygnanski the velocity of the two streams should be different.

Active forcing is not always necessary for the new invention. In some cases, when the velocity difference of the two streams is very high and the average velocity is also very high, and tube size is sufficiently small, the mixing is very fast without active forcing due to the initial corner vortices and some secondary flow resulted from the confinement of the flow.

In Wygnanski the active element is driven in the vicinity of the beginning of the mixing region to induce the oscillation of the fluids normal to the mixing region flow axis. With the claimed invention, the forcing method can be more flexible, i.e., any actuator, which can oscillate one or two streams before or near the beginning of the mixing region, is applicable.

In summary, although there is splitter plate and tube, Wygnanski does not induce said streamwise vortices due to said corners. In the claimed invention the streamwise vortices are necessary. The forcing of the corner vortices is the main mechanism of the new invention for the dramatic mixing enhancement.

Specification

Examiner states that the specification is objected to in terms of its arrangement and that it does not contain an abstract. Agent for Applicant respectfully submits a substitute specification that arranges the patent in accordance with 37 CFR, as well as clarifying the invention **without adding new matter**. Agent for Applicant respectfully submits to assist the Examiner by enclosing a copy of the original application, a compare rite version of the substitute specification with the original application and a clean copy of the substitute application.

Appointment of Agent

Agent for Applicant includes an executed Appointment of Agent form.

Priority Document

Agent of Applicant has requested a certified copy of the priority document but has not received it as yet. Agent will forward the priority document once they receive it.

Figures

Agent for Applicant has deleted Figure 2 and included new Figure 2, which shows the invention more clearly without adding new matter.

Conclusion

Applicant respectfully states that the application is now in a condition for immediate allowance and respectfully solicits same.

Yours faithfully,

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